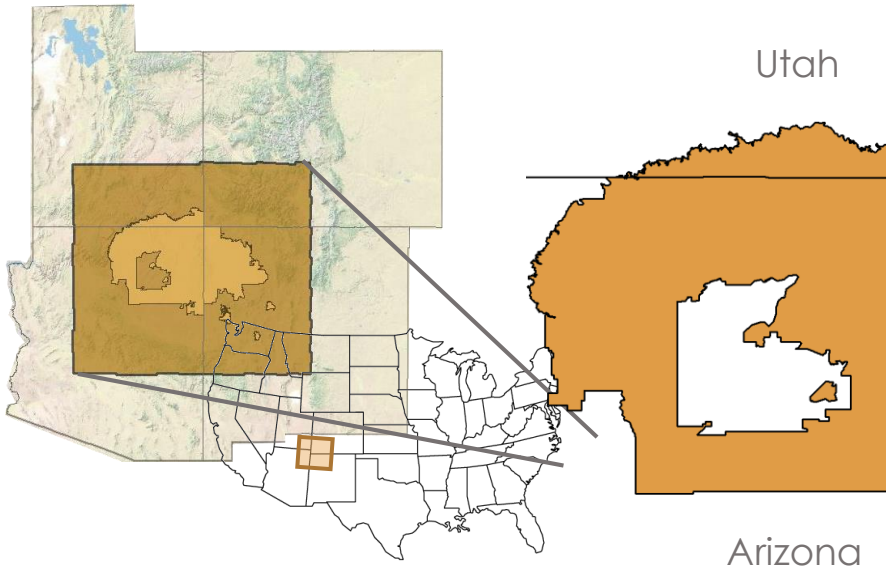
Monitoring Drought Conditions in the Navajo Nation Using NASA Earth Observations

NASA DEVELOP Climate project

Vickie Ly
Michael Gao
Cheryl Cary
Sophie Turnbull-Appell
Anton Surunis

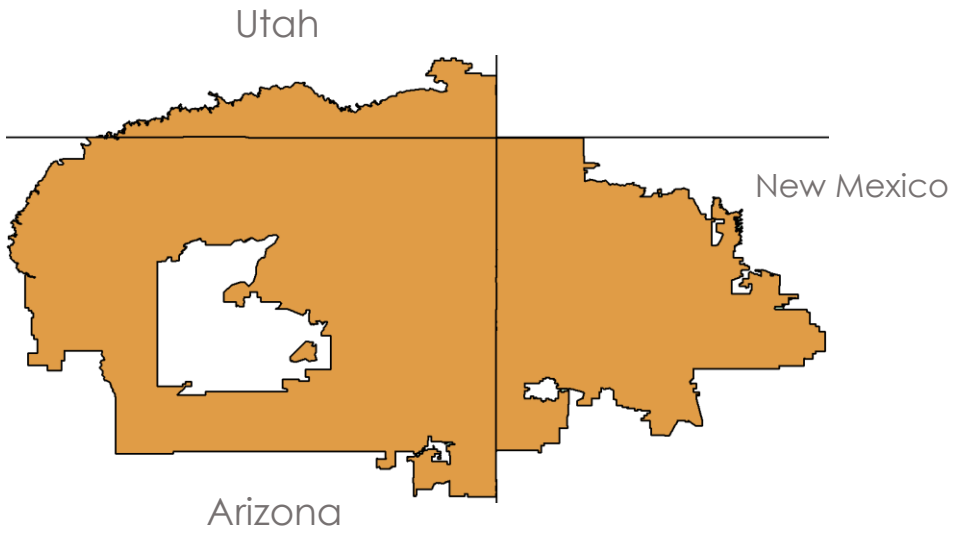
The Navajo Nation

Drought in the Navajo Nation



- 12 EPA lvl. IV Ecoregions
- Semi-arid highlands
- Forested Mountains

Drought in the Navajo Nation



Decreasing Precipitation

70,000+ residents without water

Increasing Temperatures

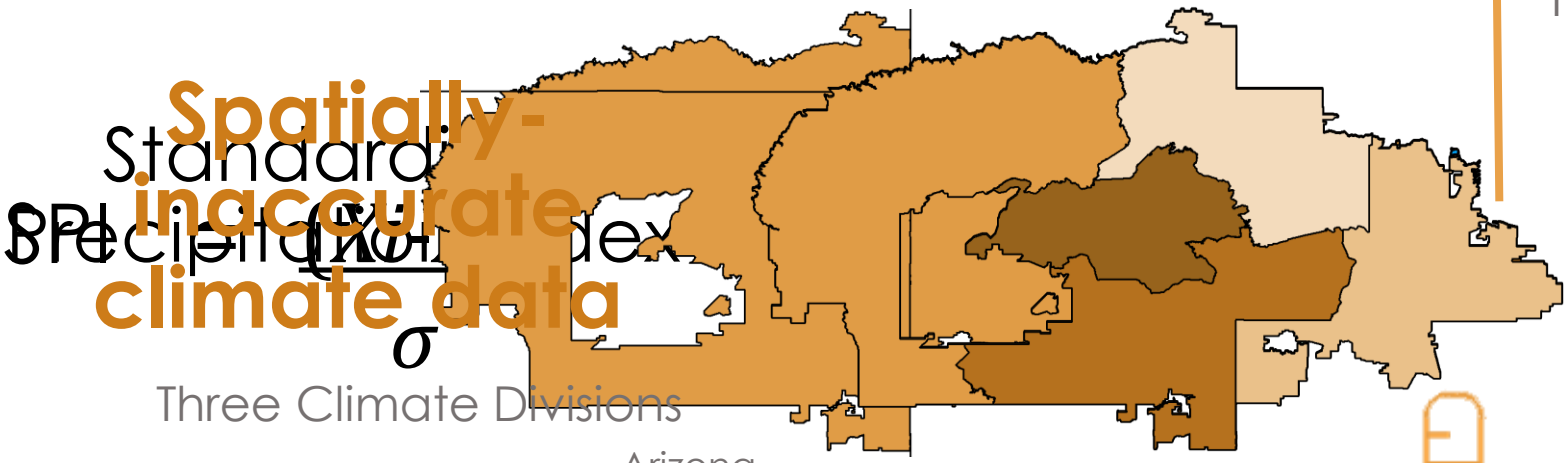
Objectives

Issues in Drought Monitoring

NASA DEVELOP & Navajo Nation

Five Agencies

Term 1



Three Climate Divisions

Spatially-inaccurate climate data

Standardized Precipitation Index

$$\frac{(X_i - \bar{X})}{\sigma}$$

X_i = accumulated precipitation over months of interest

$\bar{X}$ = historical avg. accumulated precipitation over months of interest

σ = standard deviation

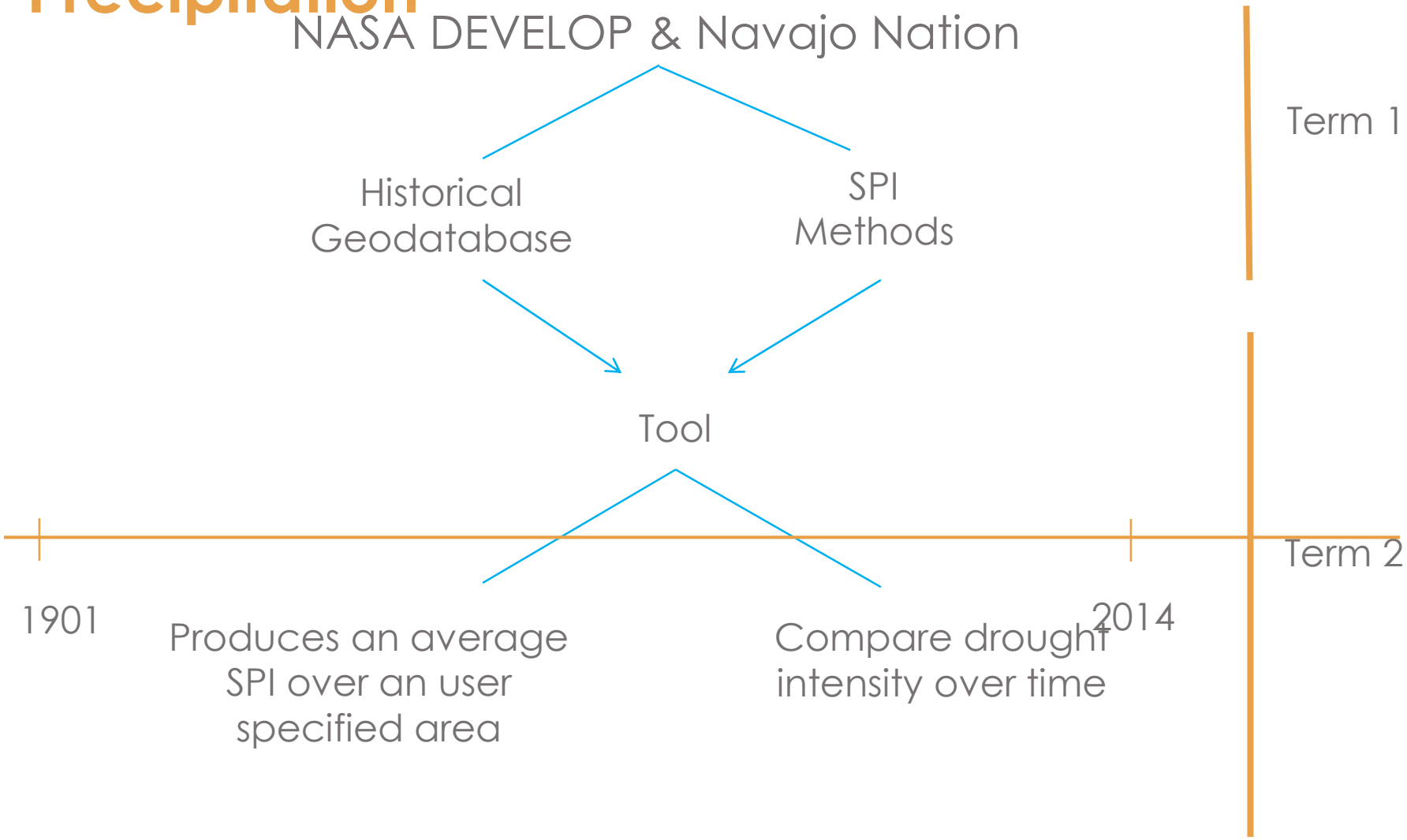
Decreasing Precipitation

70,000+ residents without water

Inadequate rain gauge coverage

Increasing Temperatures

Tool Data: Accumulated Monthly Precipitation



Tool Data: Accumulated Monthly Precipitation

PRISM

Parameter-elevation Relationships on Independent Slopes Model

TRMM

Tropical Rainfall Measuring Mission

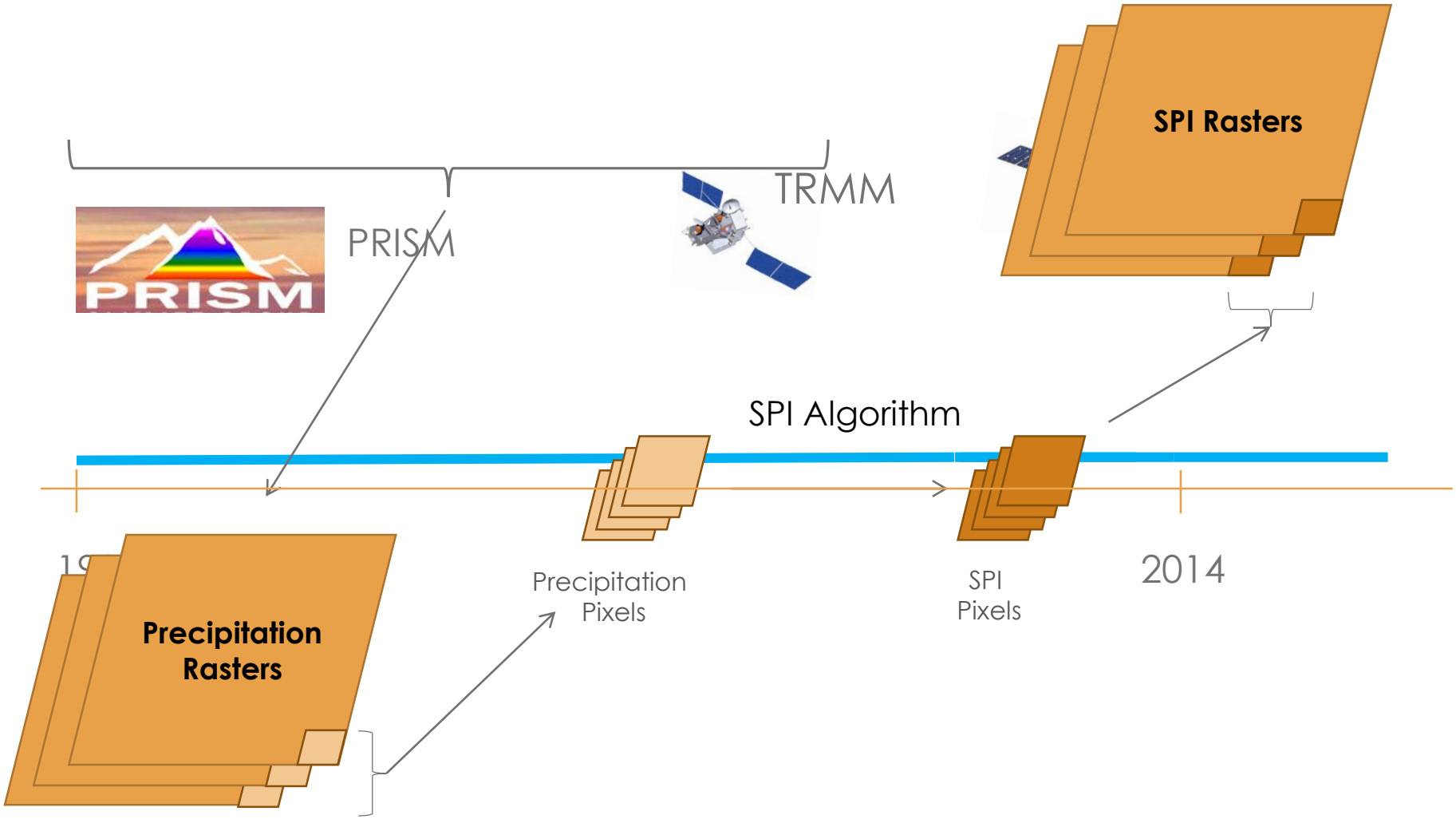
GPM

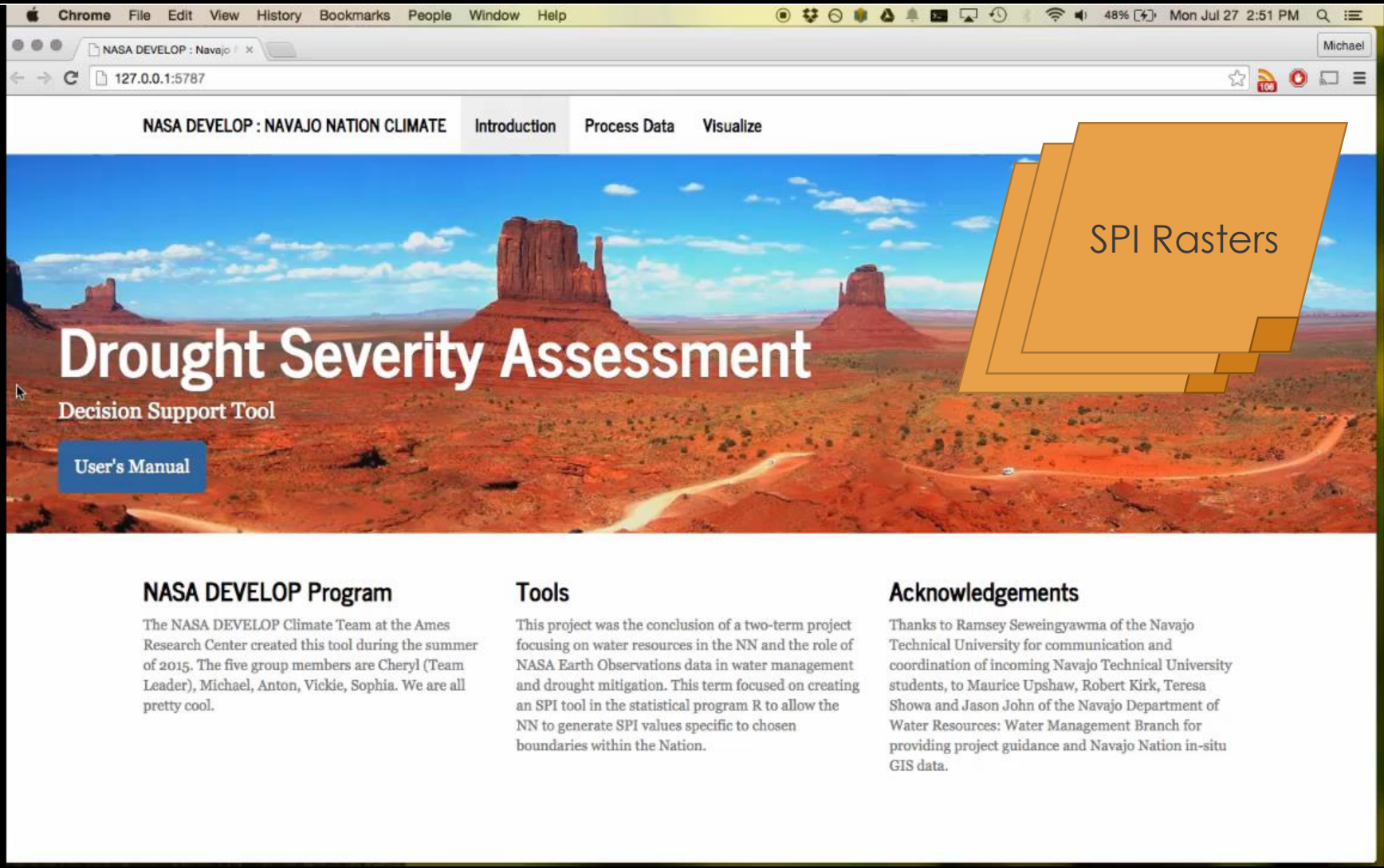
Global Precipitation Measurement

1901

2014

Tool Data: Accumulated Monthly Precipitation

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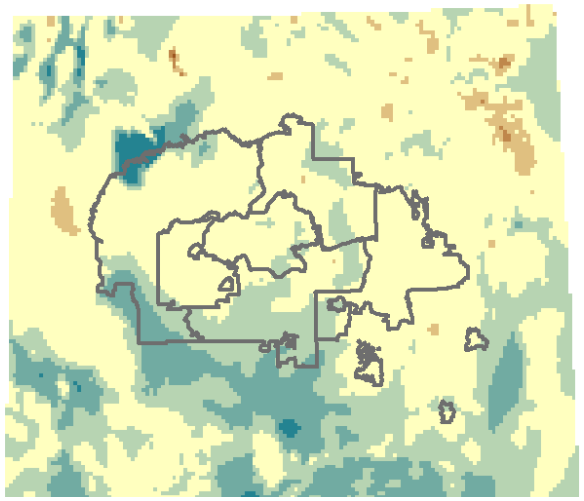
NASA DEVELOP : Navajo
Michael
127.0.0.1:5787
NASA DEVELOP : NAVAJO NATION CLIMATE
Introduction
Process Data
Visualize
SPI Rasters
Drought Severity Assessment
Decision Support Tool
User's Manual
NASA DEVELOP Program
The NASA DEVELOP Climate Team at the Ames Research Center created this tool during the summer of 2015. The five group members are Cheryl (Team Leader), Michael, Anton, Vickie, Sophia. We are all pretty cool.
Tools
This project was the conclusion of a two-term project focusing on water resources in the NN and the role of NASA Earth Observations data in water management and drought mitigation. This term focused on creating an SPI tool in the statistical program R to allow the NN to generate SPI values specific to chosen boundaries within the Nation.
Acknowledgements
Thanks to Ramsey Seweingyawma of the Navajo Technical University for communication and coordination of incoming Navajo Technical University students, to Maurice Upshaw, Robert Kirk, Teresa Showa and Jason John of the Navajo Department of Water Resources: Water Management Branch for providing project guidance and Navajo Nation in-situ GIS data.

Results of Tool

by Classification



Dec 2014
SPI Value

- < -1.99
- -1.99 to -1.50
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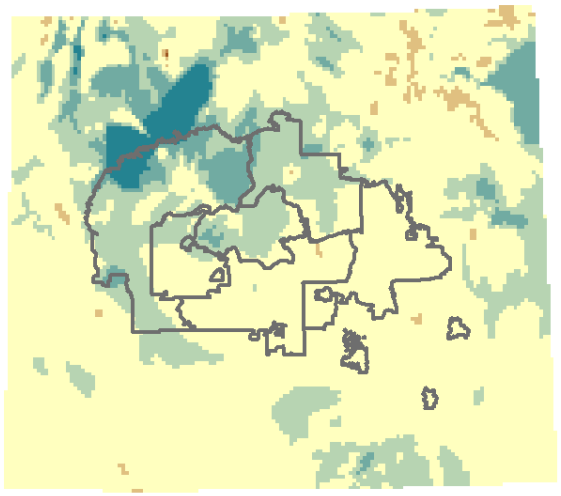
- 1.0 to 1.49
- 1.50 to 1.99
- > 1.99



Jan 2014
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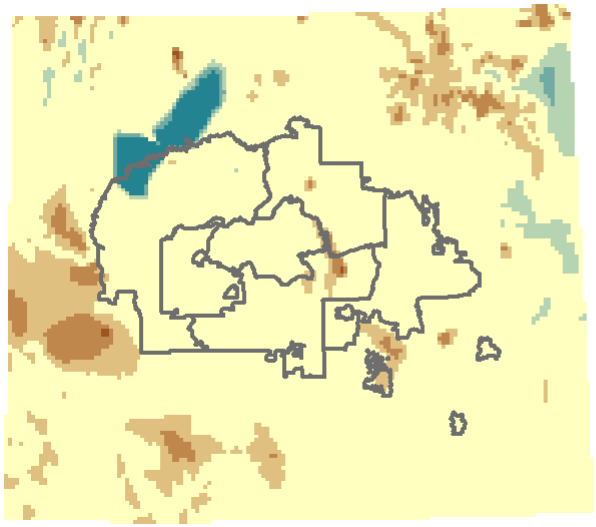

Feb 2014
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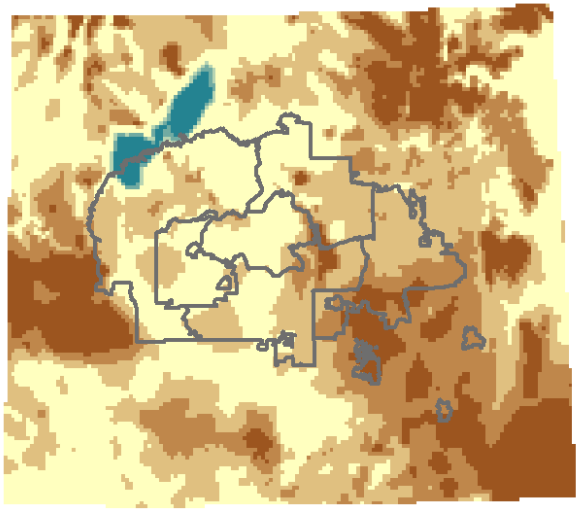

March 2014
SPI Value

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- -1.99 to -1.50
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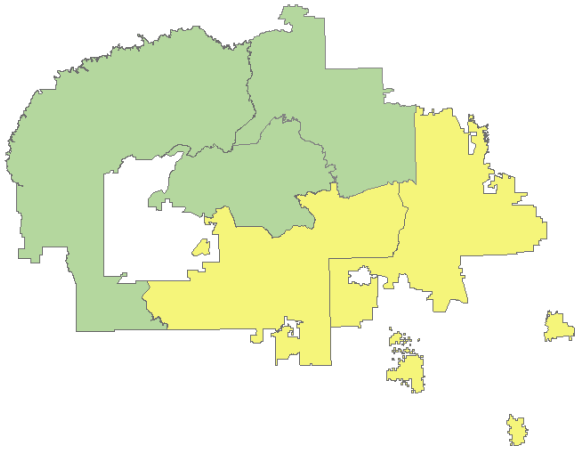
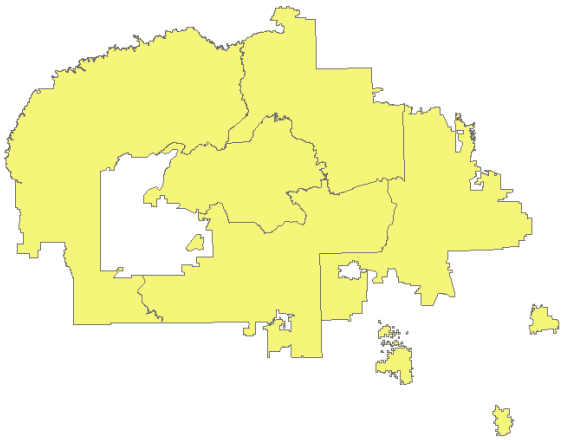
Results of Tool

by Agency



Jan 2014
Agency SPI Values

- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet



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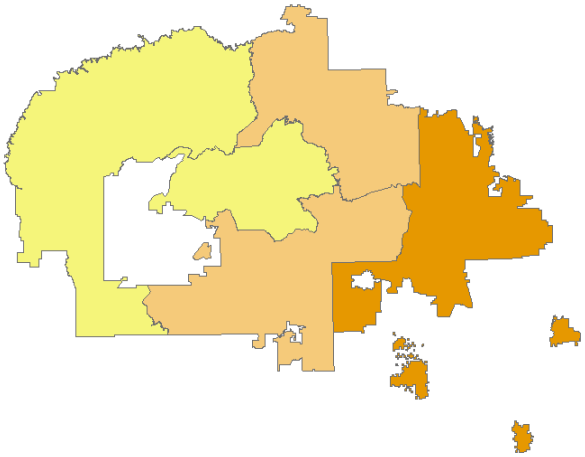

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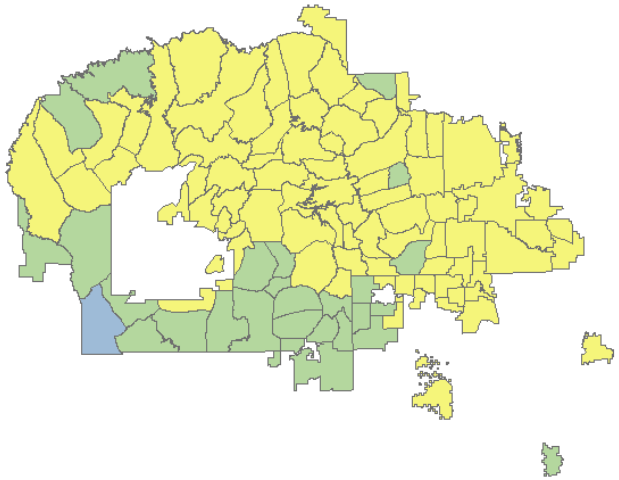
Results of Tool

by Chapter



Dec 2014

Chapter SPI Values

- Extremely Dry
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- Near Normal
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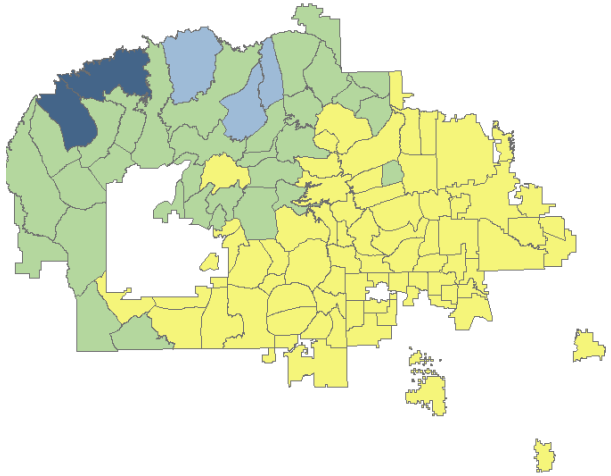
- Severely Wet
- Extremely Wet



Jan 2014

Chapter SPI Values

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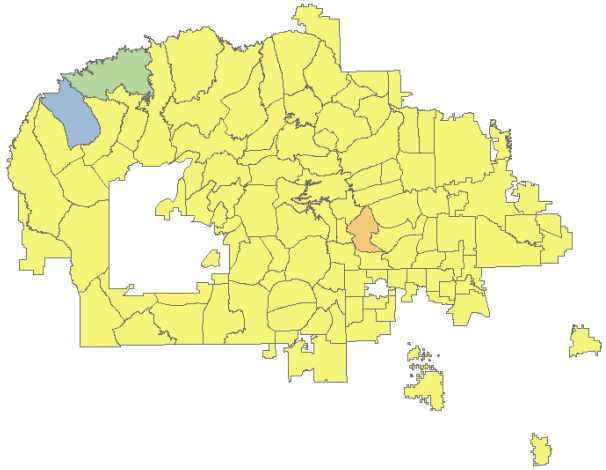

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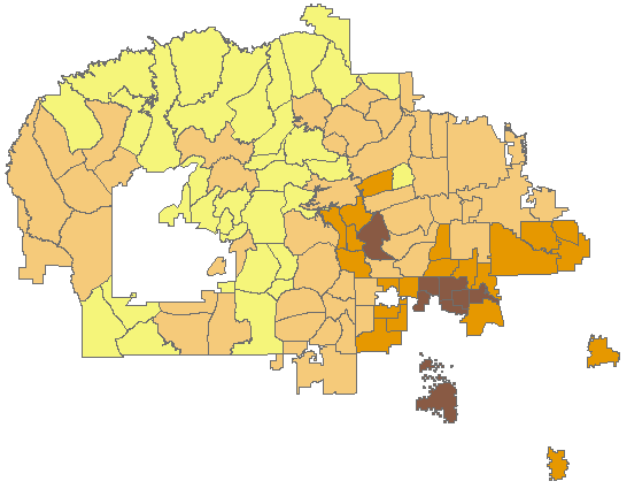

March 2014

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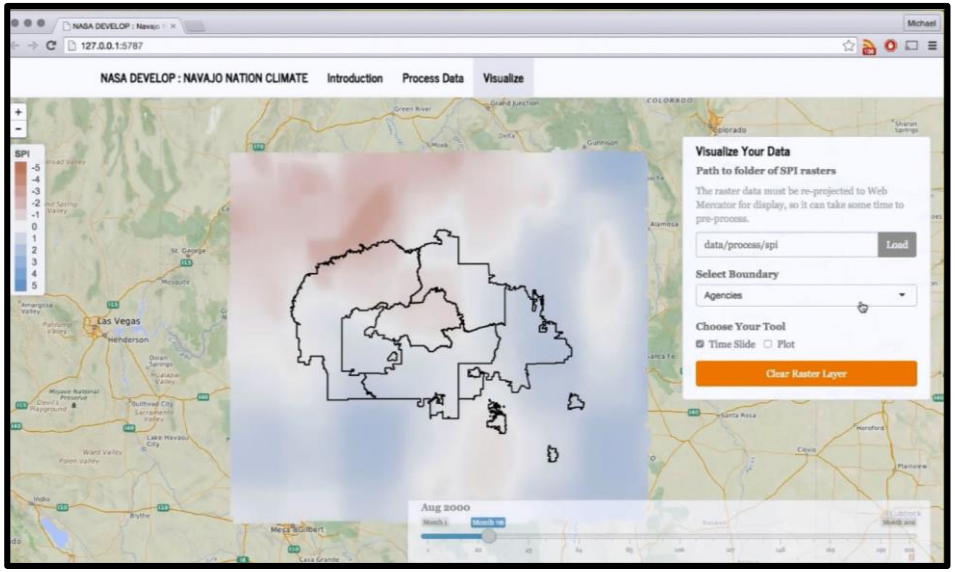
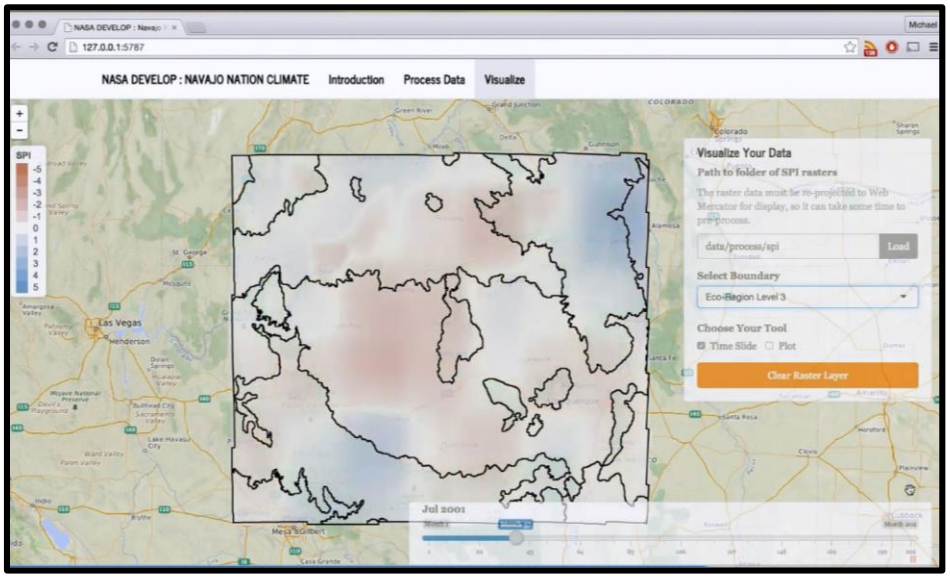
Recap

Using data from 3 different sources

Benefits of Research

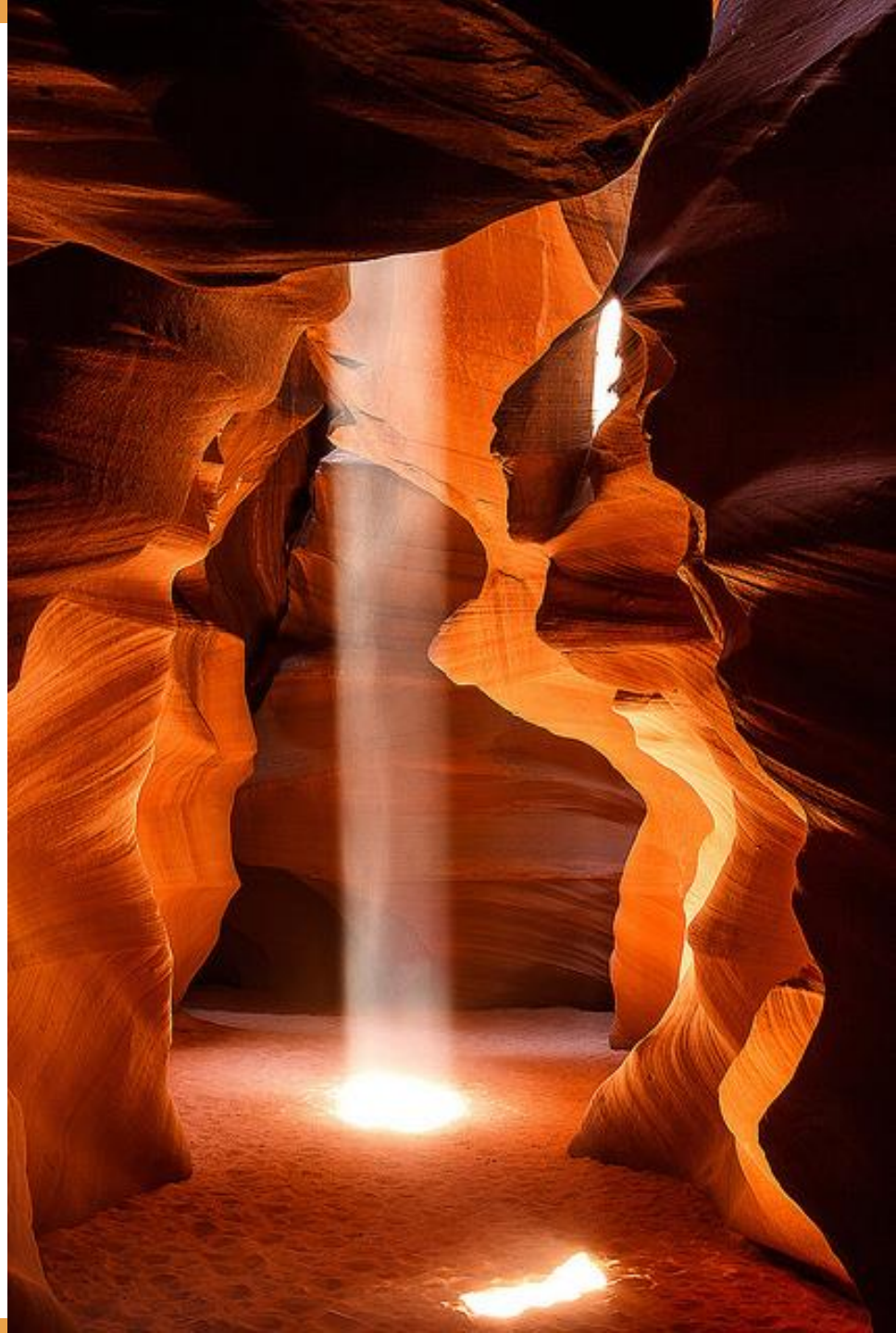
- **Calculate SPI-specific** to the Navajo Nation
- **Produce monthly drought reports** with current and historical data
- **Allocate drought dollars** in most impacted areas





Future Work

- **Continue** building partnerships with Navajo Nation
- **Applications** to other tribal and rural communities
- **Understanding drought** regime changes



Acknowledgements

Advisors

Dr. Jay W. Skiles, NASA Ames

Dr. Venkat Lakshmi, University of South Carolina

Dr. Juan Torres-Peres, NASA Ames

Partners

Navajo Nation Department of Water Resources: Water Management Branch

Teresa Showa :: Robert Kirk :: Maurice Upshaw

Crystal Lynn Tulley-Cordova :: Carl McLennan

Navajo Technical University

Ramsey Seweingyawna

DEVELOP Staff

NASA DEVELOP National Program

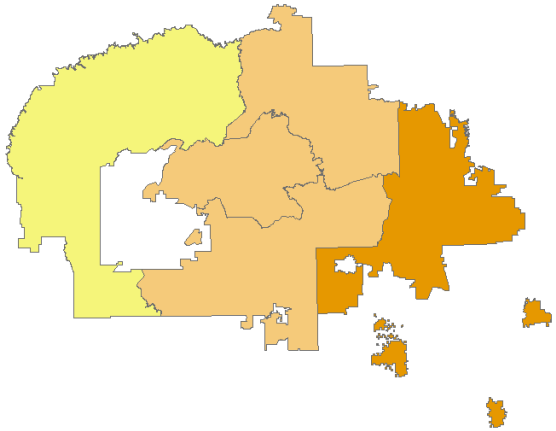
Clayton Sodergren :: Amber Brooks :: Chippie Kislik :: Andrew Nguyen

This material is based upon work supported by NASA through contract NNL11AA00B and cooperative agreement NNX14AB60A.


Thank you!

Results of Tool

by Agency



April 2104
Agency SPI Values

- Extremely Dry
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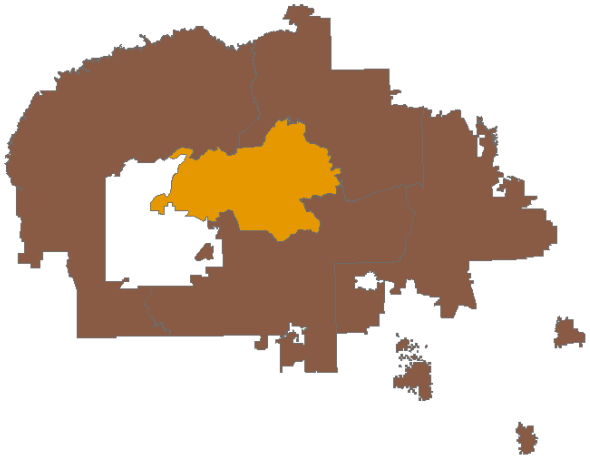

May 2014
Agency SPI Value

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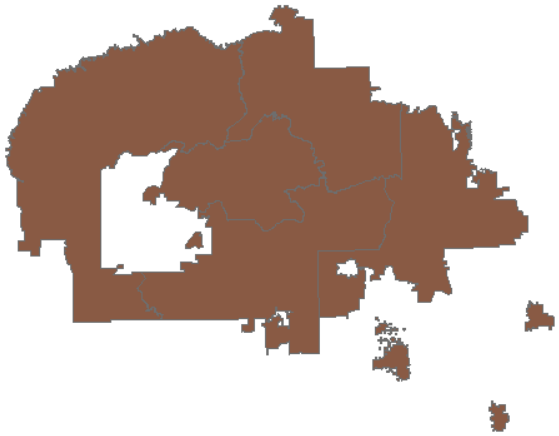

June 2014
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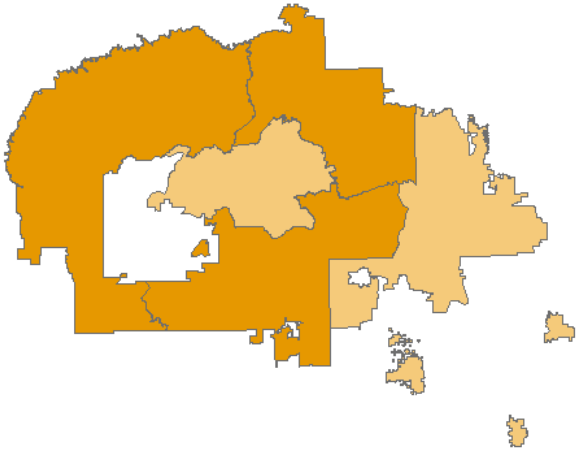

July 2014
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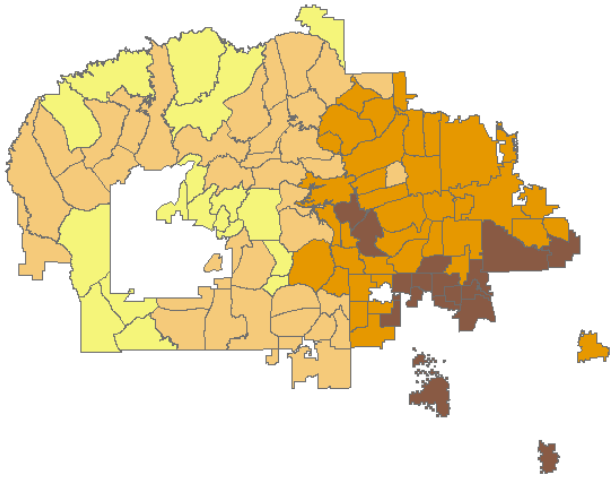
Results of Tool

by Chapter



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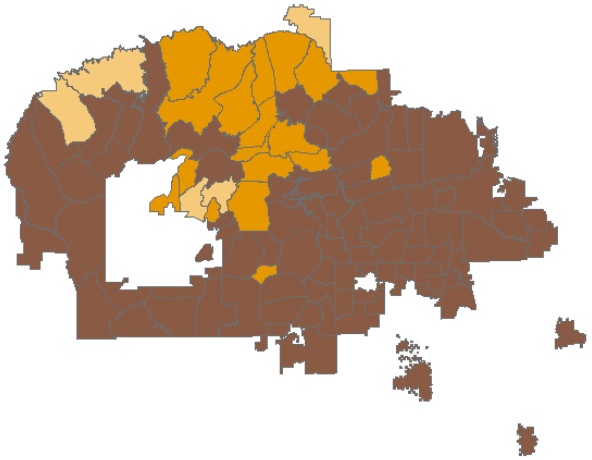

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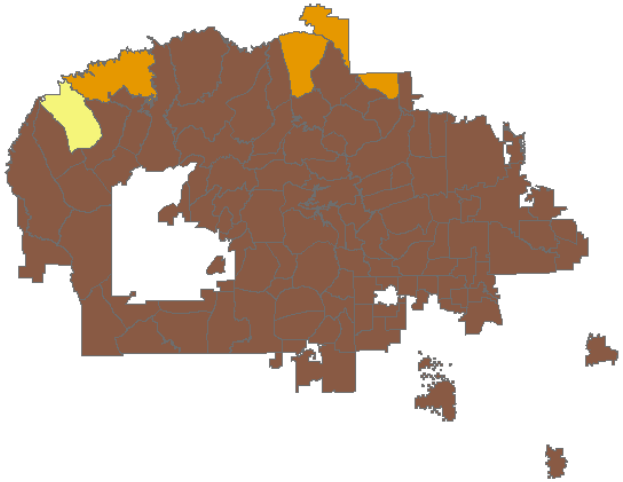

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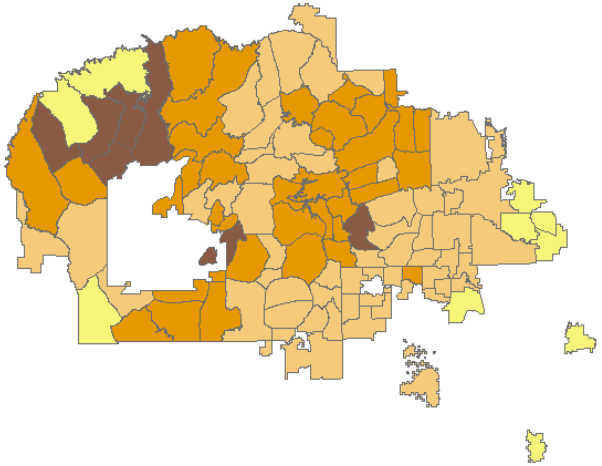

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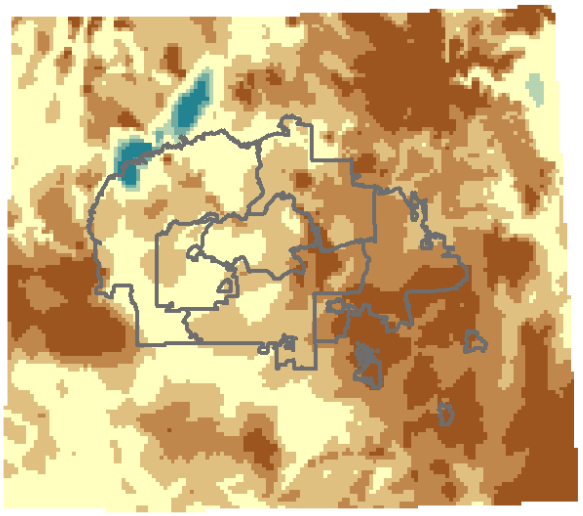

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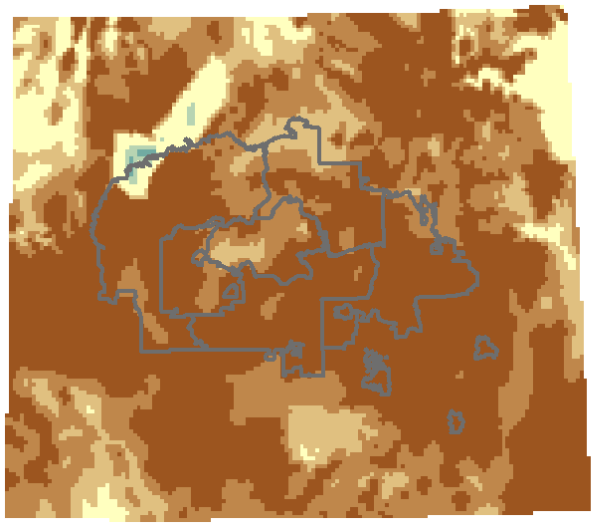

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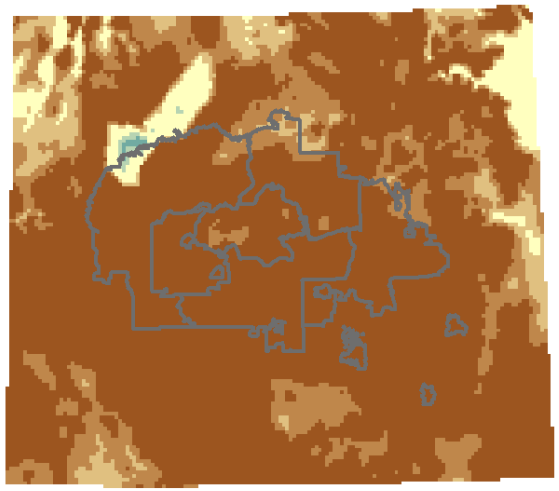

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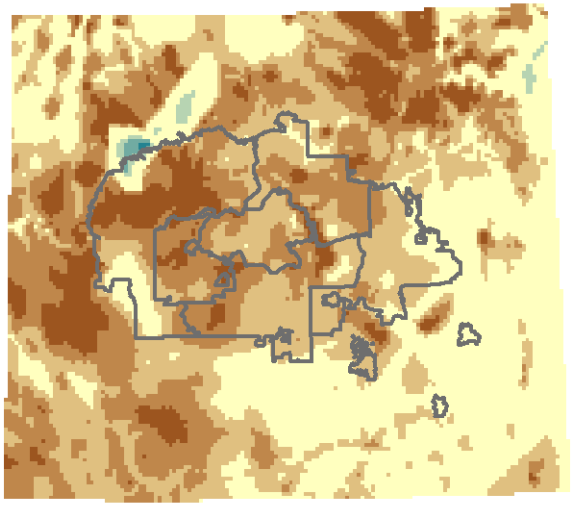

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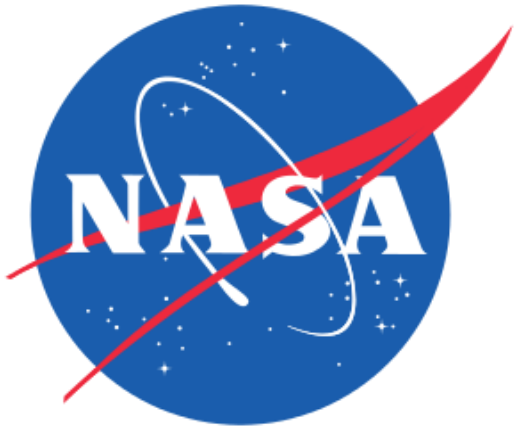
Navajo Nation Drought Monitoring Tool workshop

Introducing RAINN

Vickie Ly



Climate

Disaster

Water Resources

Energy

Ocean

Agriculture

Agenda

Introductions

Tool -- *Installation*

- Data
- Backend
- Frontend

Tool - *Testing*

- Troubleshooting
- Bugs
- Feedback

Data

ftp://ftp.chg.ucsb.edu/pub/org/chg/products/CHIRPS-2.0/

Index of /pub/org/chg/products/CHIRPS-2.0/

Name	Size	Date Modified
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prelim/		1/7/16, 11:56:00 PM
pubs/		12/1/15, 6:14:00 PM
whem_daily/		11/21/15, 12:10:00 AM

ftp://ftp.chg.ucsb.edu/pub/org/chg/products/CHIRPS-2.0/global_monthly/

Index of /pub/org/chg/products/CHIRPS-2.0/global_monthly/

Name	Size	Date Modified
[parent directory]		
bils/		3/17/16, 5:26:00 AM
netcdf/		2/13/16, 6:23:00 PM
tifs/		3/17/16, 3:12:00 PM

ftp://ftp.chg.ucsb.edu/pub/org/chg/products/CHIRPS-2.0/global_monthly/tifs/

Index of /pub/org/chg/products/CHIRPS-2.0/global_n

Name	Size	Date Modified
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chirps-v2.0.1981.01.tif.gz	13.8 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1981.02.tif.gz	13.9 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1981.03.tif.gz	13.8 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1981.04.tif.gz	13.8 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1981.05.tif.gz	13.9 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1981.06.tif.gz	14.0 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1981.07.tif.gz	14.0 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1981.08.tif.gz	14.0 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1981.09.tif.gz	13.9 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1981.10.tif.gz	13.9 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1981.11.tif.gz	13.9 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1981.12.tif.gz	13.9 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1982.01.tif.gz	13.8 MB	1/30/15, 12:00:00 AM
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chirps-v2.0.1982.03.tif.gz	13.8 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1982.04.tif.gz	13.8 MB	1/30/15, 12:00:00 AM
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chirps-v2.0.1982.08.tif.gz	14.0 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1982.09.tif.gz	13.9 MB	1/30/15, 12:00:00 AM
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chirps-v2.0.1982.11.tif.gz	13.9 MB	1/30/15, 12:00:00 AM
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chirps-v2.0.1983.07.tif.gz	14.0 MB	1/30/15, 12:00:00 AM
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chirps-v2.0.1984.01.tif.gz	13.8 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1984.02.tif.gz	13.9 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1984.03.tif.gz	13.8 MB	1/30/15, 12:00:00 AM
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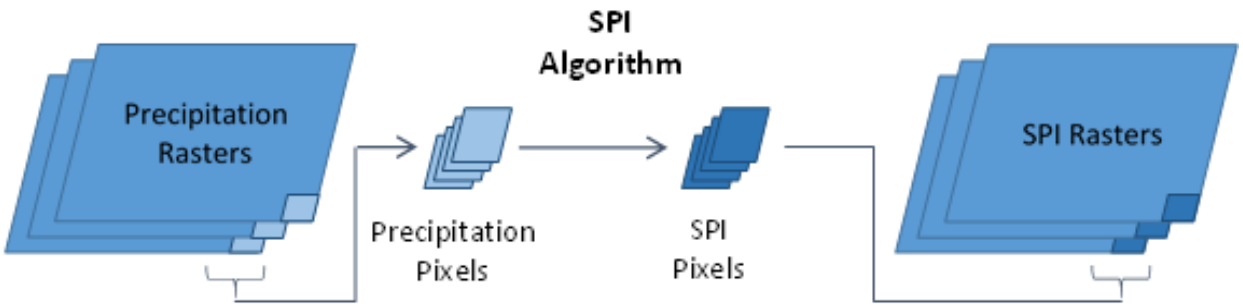
chirps-v2.0.1984.06.tif.gz	14.0 MB	1/30/15, 12:00:00 AM
chirps-v2.0.1984.07.tif.gz	14.0 MB	1/30/15, 12:00:00 AM

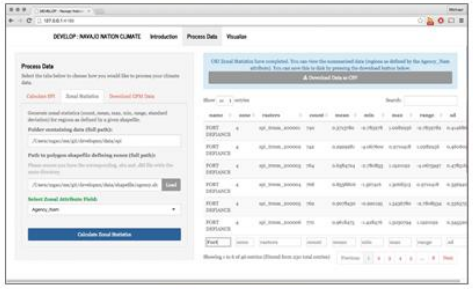
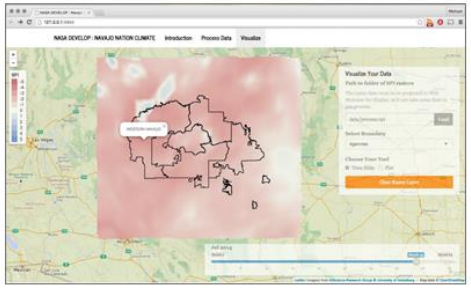
Methodology



Methodology workflow to calculate SPI raasters

RAINN

d**R**ought
Assessment
Index for
monitori**N**g
precipitatio**N**

User Interface	Functions
	**Calculate SPI Values** Creates 6-, 12-, 18-, and 24-month SPI Rasters from a database of historical precipitation raster data.
	**Calculate Summary Statistics** Calculates basic SPI statistics based on user-selected boundaries, as well as what percentage of a boundary is experiencing specific drought severity.
	**Visualize Drought Severity** Allows users to view SPI rasters though time.

Let's try it!

- Make sure R 3.2.4 is installed
- Download file and save onto C drive
- Open Rstudio
- Open manual

Installation

```
> setwd("C:/developnn")
> require(shiny)
> runApp()
```

Test and Run

Troubleshooting

- Questions?
- Bugs?
- Feedback?

Acknowledgements

Advisors

Dr. Venkat Lakshmi, University of South Carolina

Dr. Jay W. Skiles, NASA Ames

Dr. Juan Torres-Peres, NASA Ames

Partners

Navajo Nation Department of Water Resources: Water Management Branch

Teresa Showa :: Robert Kirk :: Maurice Upshaw

Crystal Lynn Tulley-Cordova :: Carl McLennan

Navajo Technical University

Ramsey Seweingyawna

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This material is based upon work supported by NASA through contract NNL11AA00B and cooperative agreement NNX14AB60A.

Thank you!